

Original Research Article

COOKING QUALITIES OF THIN LAYERED HUMIDIFIED PADDY

ABSTRACT

There was a thin layer dryer at IICPT, Thanjavur, the heating section of the dryer was replaced with humidification chamber. ~~The humidification chamber was designed and fabricated at IICPT workshop.~~ The equipment consists of a blower which sucks ambient air, which was passed through heater coils. There was a nozzle located after the heating unit, which sprays water as tiny droplets. The heated air was passed on the tiny droplets of the water, now the air gets humidified and is passed on to the paddy which was placed in a perforated tray as thin layer. After under going humidification (soaking), steaming, drying and milling, the cooking qualities of the humidified paddy were determined. The extent of humidification of paddy was studied by knowing the cooking characteristics of the parboiled rice. The different cooking qualities determined during the study were cooking time, water uptake ratio, grain elongation ratio on cooking.

Keywords: Soak water, Thin layer, Humidification chamber and Moisture content.

INTRODUCTION

There are several studies carried on parboiling of paddy using different equipments. Rice mills processing paddy after parboiling will discharge large quantities soak water as an effluent and this effluent is an environmental concern (Ramalingam & ~~and~~ ~~Anthoni Raj~~, 1996). Paddy soaked for 2-3 days in conventional rice mills which follow the traditional cold-soaking and double steaming methods. There are development of off-flavours during soaking of paddy due to fermentative changes and the water discharged in land and sewers is a public health nuisance (Charlton, 1923).

Rice mills process several tonnes of paddy per day. For parboiling, they require large quantities of water and more than half of this water becomes ~~as~~ effluent. According to ~~pollutin~~ control board, the effluents coming from the industries must be treated and it incurs additional cost. It must not be discharged into rivers and ponds as it ~~is was~~ contaminated ~~and~~. ~~There will be~~ lots of insects and pests build up due to stagnant water in the rice mill

Comment [A.1]: PLEASE RECONSTRUCT

A thin layer dryer was modified by replacing the heating section with

Comment [A.2]: Not necessary in the abstract ...

Comment [A.3]: The result obtained in this same order should be reported because abstract consists of four parts.....

...Introduction (including justification and objectives)
...Methodology
... Results
.... Conclusion (including inferences drawn from the study)

Comment [A.4]: Anthoniraj

Comment [A.5]: Check..... pollution

31 | surrounding ~~of rice mills~~ (Ramalingam & Anthoniraj, 1995). So this study can eliminate the
32 | soak water by humid air for under going the soaking process.

33 | As there are lot of environmental affects due to the effluent produced during soaking
34 | of paddy, a study was under taken at IICPT, Thanjavur to minimize effluent in soaking
35 | process by designing and developing a new technique for soaking of paddy which produce
36 | zero effluent. The ultimate aim of this study ~~was~~ to overcome all the above mentioned
37 | factors and ~~to~~ come up with a ~~good~~ solution to modern ~~parboiling~~-rice parboiling mills. The
38 | paddy was humidified, steamed, dried and milled. After that the humidified paddy was
39 | subjected for cooking studies.

Comment [A.6]: Full meaning

Comment [A.7]: Country and more details

Comment [A.8]: This should be under methodology

40 | MATERIALS AND METHODS

41 | Flow chart of the study

42 | Air is sucked through suction valve

43 | (Valve positions 1/4th, 1/2th, 3/4th and full)



45 | Air at suitable velocity is passed on the heating unit

46 | (2.05 to 7.15m/s)



48 | The heating unit is set at required temperature to heat the air

49 | (55 to 80°C)



51 | The heated air is passed perpendicular to the water jet

52 | (droplets of water from nozzle at a flow rate of 1l/h to 10.05l/h)



55 | The air is humidified

56 | (RH of 65 to 93.75%)

The humidified air is passed on to paddy in thin layer

Moisture absorption studies of paddy

Milling studies

Cooking qualities

Comment [A.9]: This chart can be further reviewed to be more explanatory and simple enough.....this is wasting lots of spaces

COOKING QUALITIES

The different cooking qualities determined during the study were cooking time, water uptake ratio, grain elongation ratio on cooking.

Cooking time:

Five grams of milled rice of each sample were weighed in triplicate and poured into 135ml of vigorously boiling distilled water in a 400ml beaker and covered with a watch glass. After 10minutes of further boiling, 10 grains were taken out every minute with a perforated ladle. The grains were pressed between two petri dishes and were considered cooked when at least 9 out of 10 grains no longer had opaque centers. The time was then recorded (Oko *et al.*, 2012).

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Water uptake ratio:

Rice was cooked in excess water. Two grams' rice was cooked with 20 ml water in a 100 ml beaker placed on an electric heater. Samples were removed at cooking time to weigh and calculated by equation (Sareepuang *et al.*, 2008).

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$$\text{Water uptake ratio (\%)} = \frac{\text{weight of cooked rice}}{\text{weight of raw rice}} \quad (1)$$

83 | **Elongation ratio on cooking:**

84 | Rice was cooked in excess water. Two grams’ rice was cooked with 20 ml water in a 100 ml
85 | beaker placed on an electric heater. Samples were removed at cooking time to measure with
86 | length and wide (before and after cooked) and calculated by equation (Sareepuang *et al.*,
87 | 2008).

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88 | **Data Analysis**

Comment [A.11]: Indicate the software and method used for the analysis of data

89 |
$$\text{Elongation ratio} = \frac{\text{Average length of cooked grains}}{\text{Average length of raw grains}} \quad (2)$$

90 | **RESULTS AND DISCUSSIONS**

91 | **Cooking time**

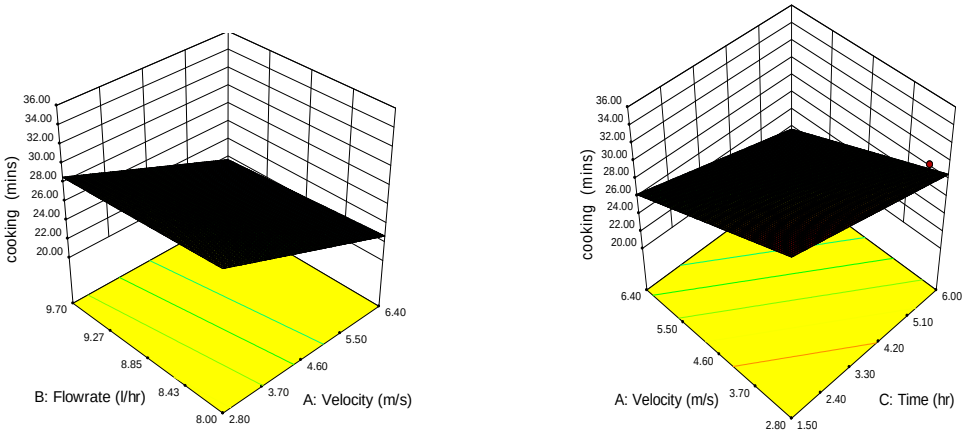
92 | Cooking time is a function of gelatinization temperature, as the gelatinization temperature
93 | ~~was more increased~~, the cooking time of rice ~~was also more increased~~, a similar trend was
94 | ~~reported by~~ (Oko *et al.*, (2012). ~~The~~ Cooking time decreases with increase in soaking
95 | ~~temperature~~ (Sareepaung *et al.*, 2008). Here in this study we observed minimum cooking time
96 | of 21 minutes at a maximum humidification period of 5.34 hours. The effect of water flow
97 | rate, velocity and time on cooking time ~~were-is~~ shown in the following Figure 1.:

Comment [A.12]: State the scientific reason for this trend..... repeat same for all the quality parameters determined

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Comment [A.13]: What is the reason behind this

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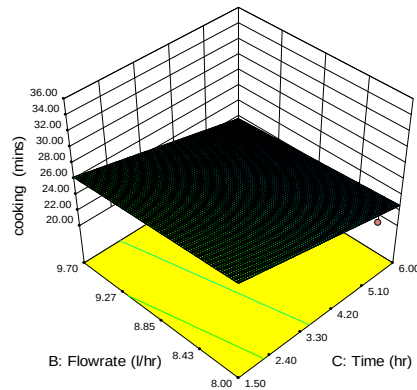


Fig 1: Variation of cooking time with velocity, flow rate and humidification

Using the design expert 10.02 (Stat-Ease) RSM, ~~that~~ a linear model is adequate for modelling the cooking time. The step-wise method was employed to eliminate the insignificant model-terms. Test for significance of the regression model and the lack-of-fit test were also performed. From the analysis of variance (ANOVA), the following coded equation for the temperature(Y_1) can be devised:

$$Y_1 = 28.14 - 3.53A - 0.53B - 2.39C \quad (3)$$

Where $-1 \leq A, B, C \leq 1$ corresponds to:

A: $2.05 \leq \text{velocity} \leq 7.15$

B: $7.65 \leq \text{flow rate} \leq 10.05$

C: $0.57 \leq \text{time} \leq 6.93$

The adjusted R^2 coefficient, predicted R^2 coefficient and the adequate precision are found to be 0.8245, 0.6576 and 11.992 respectively. The Predicted R^2 of 0.6576 is in reasonable agreement with the adjusted R^2 0.8245, i.e. the difference is less than 0.2. "Adeq Precision" measures the signal to noise ratio. A ratio greater than 4 is desirable. The ratio of 11.992 indicates an adequate signal. This model can be used to navigate the design space.

Comment [A.14]: This should be moved to data analysis under methodology

Comment [A.15]: State why linear model was chosen above other models

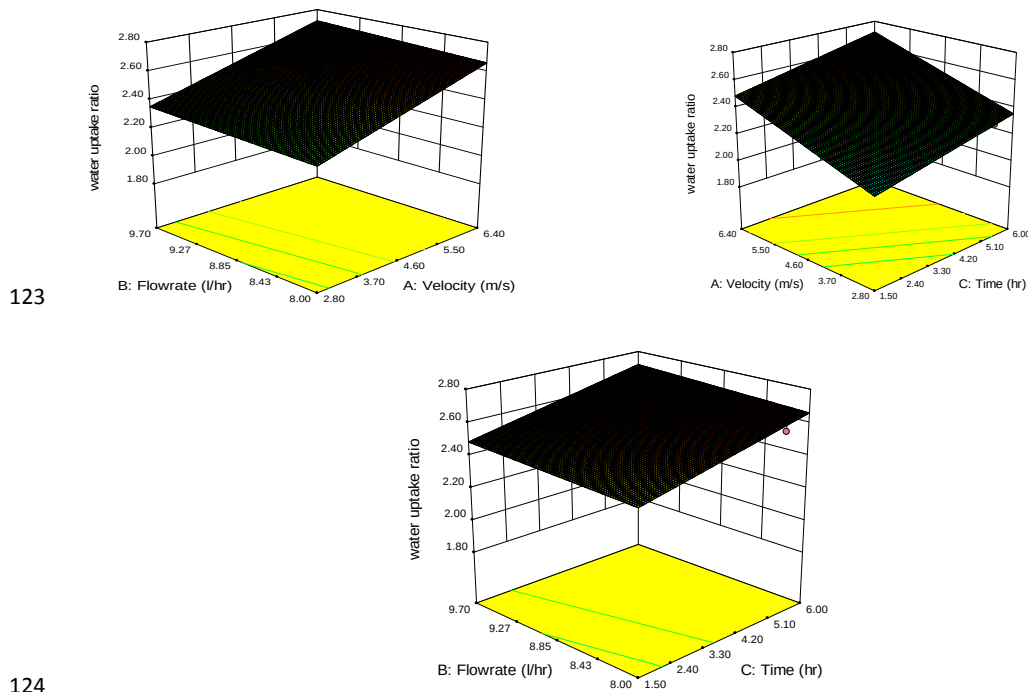
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118 Water uptake ratio

119 The water uptake ratio was increased with increase in duration of soaking and
 120 moisture absorbed (Ayamdoo et al., 2014). The maximum water uptake ratio was observed at
 121 maximum humidification time of 5.34 hours which was 2.63 where the relative humidity was
 122 93.35%, flow rate 9.70l/h and velocity was 6.40m/s which was shown in Figure 2.



125 **Fig 2: Variation of water uptake ratio with velocity, flow rate and humidification time**

126 Using the design expert 10.02 (Stat-Ease) RSM, that a linear model is adequate for
 127 modelling the water uptake ratio. The step-wise method was employed to eliminate the
 128 insignificant model-terms. Test for significance of the regression model and the lack-of-fit
 129 test were also performed. From the analysis of variance (ANOVA), the following coded
 130 equation for the water uptake ratio(Y_2) can be devised:

$$131 \quad Y_2 = 2.39 + 0.18A + 0.027B + 0.11C \quad (4)$$

132 Where $-1 \leq A, B, C \leq 1$ corresponds to: $A: 2.05 \leq \text{velocity} \leq 7.15$

Comment [A.19]: reconstruct, look at comments 14 to i8 above

133

B: $7.65 \leq \text{flow rate} \leq 10.05$

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C: $0.57 \leq \text{time} \leq 6.93$

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The adjusted R^2 coefficient, predicted R^2 coefficient and the adequate precision are found to be 0.8957, 0.8257 and 16.029 respectively. The Predicted R^2 of 0.8257 is in reasonable agreement with the adjusted R^2 0.8957, i.e. the difference is less than 0.2. "Adeq Precision" measures the signal to noise ratio. A ratio greater than 4 is desirable. The ratio of 16.029 indicates an adequate signal. This model can be used to navigate the design space.

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Elongation ratio

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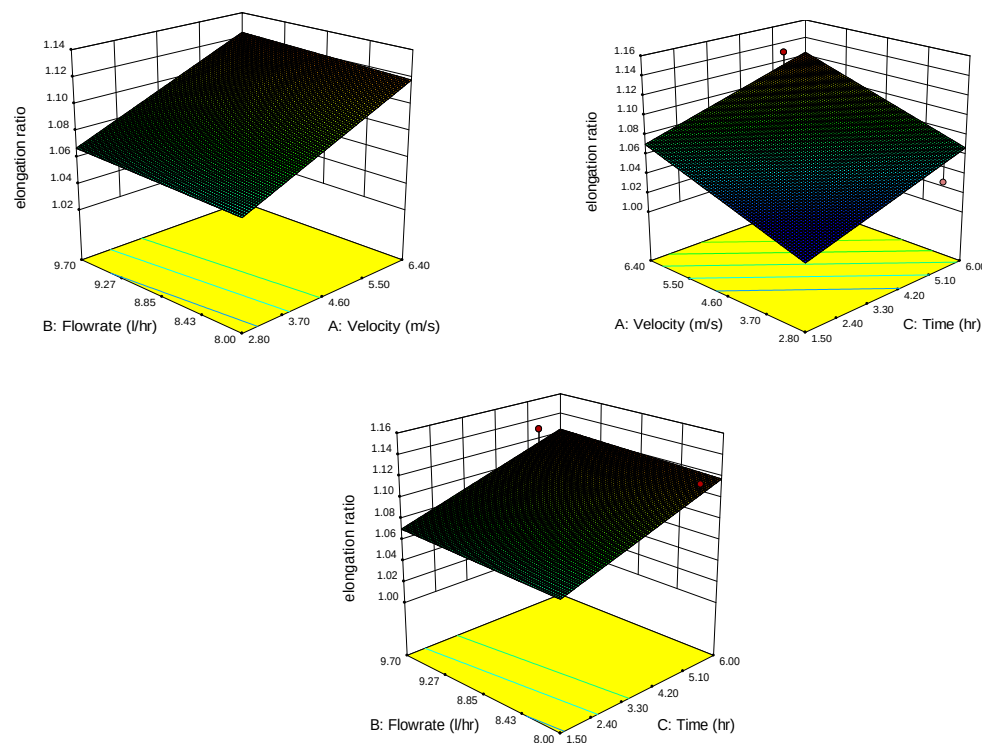
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145

The elongation ratio increased with the increase in the moisture absorption and humidification time. The effect of temperature also plays an important role in case of elongation and it will increase with increase in soaking temperature (Sareepuang *et al.*, 2008). Here the maximum elongation ratio was obtained at maximum humidification time of 5.34 hours, moisture content of 30.74% (w.b) was 1.13.

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147

Fig 3: Variation of elongation ratio with velocity, flow rate and

148 Using the design expert 10.02 (Stat-Ease) RSM, that a linear model is adequate for
149 modelling the elongation ratio. The step-wise method was employed to eliminate the
150 insignificant model-terms. Test for significance of the regression model and the lack-of-fit
151 test were also performed. From the analysis of variance (ANOVA), the following coded
152 equation for the water uptake ratio(Y_3) can be devised:

153
$$Y_3 = 1.07 + 0.028A + (3.018E-0.03) B + 0.027C \quad (5)$$

154 Where $-1 \leq A, B, C \leq 1$ corresponds to: A: $2.05 \leq \text{velocity} \leq 7.15$

155 B: $7.65 \leq \text{flow rate} \leq 10.05$

156 C: $0.57 \leq \text{time} \leq 6.93$

Comment [A.20]: reconstruct, look at comments 14 to i8 above

157 The adjusted R^2 coefficient, predicted R^2 coefficient and the adequate precision are
158 found to be 0.8206, 0.6501 and 11.453 respectively. The Predicted R^2 of 0.6501 is in
159 reasonable agreement with the adjusted R^2 0.8206, i.e. the difference is less than 0.2. "Adeq
160 Precision" measures the signal to noise ratio. A ratio greater than 4 is desirable. The ratio of
161 11.453 indicates an adequate signal. This model can be used to navigate the design space.

162 The equations in terms of coded factors can be used to make predictions about the
163 response for given levels of each factor. By default, the high levels of the factors are coded as
164 +1 and the low levels of the factors are coded as -1. The coded equation is useful for
165 identifying the relative impact of the factors by comparing the factor coefficients.

166 CONCLUSION

167 The different cooking qualities determined, cooking time decreases with increase in
168 soaking temperature here in this study we observed minimum cooking time of 21 minutes at a
169 maximum humidification period of 5.34 hours, the maximum water uptake ratio was
170 observed at maximum humidification time of 5.34 hours which was 2.63, maximum
171 elongation ratio was obtained at maximum humidification time of 5.34 hours, moisture
172 content of 30.74% (w.b) was 1.13.

Comment [A.21]: please reconstruct

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Comment [A.22]: too few and too old, get recent findings to update and upgrade the manuscript

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